R E P O R T R E S U M E S

ED 003 662 56

SIZE-OF-STEP AND ACHIEVEMENT IN PROGRAMED SPELLING.

BY- SMITH, WENDELL MOORE, J. WILLIAM
BUCKNELL UNIV., LEWISBURG, PA.

REPORT NUMBER NDEA-VIIA-485 PUB DATE SEP 61
GRANT OEG-7-36-087-00
EDRS PRICE MF-$0.09 HC-$1.00 25P.

DESCRIPTORS- *PROGRAMED INSTRUCTION, *SPELLING, ACHIEVEMENT TESTS, EXPERIMENTAL PROGRAMS, *PROGRAMED MATERIALS, *GRADE 5, LEWISBURG, PENNSYLVANIA

THE EFFECTS OF THREE SIZES-OF-STEP AND THE TYPE AND AMOUNT OF CUEING UPON ACHIEVEMENT IN SPELLING WERE COMPARED. NINETY-SIX FIFTH-GRADE PUBLIC SCHOOL STUDENTS WERE RANDOMLY ASSIGNED TO ONE OF SIX EXPERIMENTAL TREATMENTS. ALL SUBJECTS WERE MATCHED ON SEX BEFORE ASSIGNMENT. THE MEAN SCORES ON EACH OF THE WEEKLY TESTS WERE COMPARED BY AN ANALYSIS OF VARIANCE. IN NONE OF THE COMPARISONS WAS THE DIFFERENCE BETWEEN MEANS STATISTICALLY SIGNIFICANT. THE CONCLUSION WAS THAT ALL SIX METHODS WERE EQUALLY EFFECTIVE FOR TEACHING SPELLING. (LP)

ED003662

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated do not necessarily represent official Office of Education position or policy.

485

Size-of-Step and Achievement in Programed Spelling

Wendell Smith and J. William Moore

Bucknell University

Title VII Project Number 485
National Defense Education Act of 1958
Grant Number 736087

Principal Investigator: J. William Moore

J. William Moore

September 1961

The Research Reported Herein Was
Supported by a Grant from the
U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Office of Education

Size-of-Step and Achievement in Programed Spelling

Wendell Smith and J. William Moore

Bucknell University

September 1961

The research reported herein was supported by Grant No. 7-36-087.00 from the United States Office of Education, Department of Health, Education, and Welfare.

One of the important considerations in preparing programed material is the determination of an optimum size-of-step for the learner. Several meanings have developed for the concept of step-size. Carr (1959), identifies two operational definitions: (1) When used as an independent variable in an experiment, size-of-step "is usually specified as the number of steps in a program which takes the learner from the initial to the terminal stimulus-response connections. The greater the number of steps, the smaller the median size of step." (2) As a dependent variable, size-of-step "is usually specified by the percentage of incorrect responses. Thus if learners make few error responses on a given program, the size-of-step is inferred to be small." (p. 559)

Size-of-step as a concept almost inevitably is related to the concept of cueing and prompting, a relationship which has been recognized explicitly by Lumsdaine (1959) who points out that size-of-step is used in at least three major senses, depending upon the context in which the concept is found. In Lumsdaine's analysis, size-of-step may mean: (1) ". . .the difficulty of giving a correct response to any item. Also, it may refer to the difference or <u>increment</u> in difficulty between the concepts, relationships, or terminology between successive steps or sets of steps in a program." (2) ". . . the size of the <u>response segment</u> which the student is required to perform in response to the question contained in each frame of the program." (3) " . . . the interval between successive questions to which the learner is asked to respond." (pp. 531-533) Lumsdaine further points out that cueing, prompting and other techniques of programing provide a means for manipulating the independent variables upon which level of difficulty is dependent.

Typically, the size-of-step in a program is determined by the test student of <u>lowest</u> ability used in the development of the program. The assumption is made that if size-of-step is decreased to the point where the

test student of low ability can complete the program with a low rate of error, the optimum program for all students for whom the program is intended will have been developed (Amsel, 1960; Holland, 1960; Skinner, 1958). Goldbeck (1960) has reported some evidence which indicates that the relationship between error rate and achievement is not as clear as the preceding assumption would imply. It may be that providing larger steps, either by decreasing the number of frames allotted to a particular concept or by reducing the cues or prompts within a frame (or both), will not lower achievement on a criterion measure even though error rate may be increased. If this is the case, more attention should be given to student performance on a criterion measure than to the error rate for a program. It is not intended to imply that there is no relationship between achievement and error rate, only to suggest that the two are not synonymous. Therefore, the primary purpose of the present study was to compare the effects of three sizes-of-step and the type and amount of cueing upon achievement in spelling.

Some additional data on other aspects of programed learning are presented.

PROCEDURE

Subjects

Ninety-six fifth-grade public school students (Ss) were randomly assigned to one of six experimental treatments.[1,2] (The treatments are described in the next section.) As a further control, all Ss were matched

[1]Since the study was conducted during the last four weeks of the academic year, Ss were selected from the fifth grade rather than the sixth grade, even though the spelling materials were based on sixth-grade lists.

[2]This study was conducted in the elementary schools of Danville, Pa. through the cooperation of the supervisor of the elementary school, Robert Hawk.

on sex before assignment. The median I.Q. for the group was 105 and the mean age was 133 months. One fifth grade was used in each of three buildings. To reduce the effects of the teacher variable, Ss were assigned to one of 6 groups within each of the three rooms.

Experimental Treatment

One hundred sixty-four of the words most frequently included in 13 sixth-grade spelling books were selected for programing.[1] Eight units of spelling were programed in 6 forms. The forms were: (1) small-step (4-9 frames per word) with and without pictorial cues, (2) medium-step (3-7 frames per word), with and without pictorial cues, and (3) large-step (3-6 frames per word), with and without pictorial cues. A pictorial cue consisted of an illustration appropriate for each word sketched beside the word upon its first occurrence.[2] The main independent variables were, therefore, (a) the number of frames per word and, (b) the presence or absence of a pictorial cue for the first frame in which a word to be spelled appeared.

The number of spelling words programed for each unit ranged from 18 to 22. The number of frames in the small-step program was 1108, in the medium-step program it was 838, and in the large-step program it was 596.[3]

In structure, the programed material was linear and similar to that of Porter's (1961) in that the "vanishing technique" was used heavily.

---

[1]The programing was done by Mary Haupt Smith.

[2]The first frame always required S to select a word for a definition as given.

[3]A sample of the biographical context in which the words were presented to the Ss, a sample set of frames from one unit, and a table presenting the number of spelling words and the number of frames for each unit will be found in Appendix A.

Each unit was bound as a self-teaching text with the correct answers provided in a separate booklet. The Ss were instructed (a) to complete each frame, (b) to confirm immediately the correctness of their response from the answer booklet and (c) to proceed to the next frame without reviewing previous frames. No other instruction in spelling was provided.

The experimental treatment lasted four weeks during which Ss completed two units each week. Unit one, entitled Leonardo da Vinci (I), was considered a practice unit and the Ss' responses on this unit were not included in the analysis of the data. The Ss were allowed a maximum of 35 minutes for the completion of each unit.[1] The programed spelling units were used on Tuesdays and Thursdays; on Friday an orally administered spelling test consisting of all spelling words included in the two units for that week was given by the classroom teacher.

The students were pre-tested and post-tested respectively one day before and one day following the experimental period. The test was composed of a random selection of fifty words from the 164 words which were programed.

RESULTS

Achievement

To determine the effects of the three sizes-of-step and the presence or absence of pictorial cues on achievement in spelling, the mean scores on each of the weekly tests were compared by an analysis of variance. The analysis is presented in Table A. In none of the four comparisons was the

[1] The allotted time was sufficient for all Ss to complete a unit. If S completed a unit in less than 35 minutes, he was instructed to work on another subject.

TABLE A

Analysis of variance of weekly achievement tests in spelling for six experimental groups.

Test #1

N = 95

Source of variations	Sums of Squares	d.f.	Means Square
Between groups	625.17	5	125.03
Within groups	9877.99	89	110.99
Total	10503.16	94	
$F_{5,89} = \frac{125.03}{110.99} = 1.13$			(.05 = 2.33) (.01 = 3.25)

Test #2

N = 95

Source of variations	Sums of Squares	d.f.	Means Square
Between groups	309.92	5	61.98
Within groups	3418.23	89	38.41
Total	3728.15	94	
$F_{5,89} = \frac{61.98}{38.41} = 1.61$			(.05 = 2.33) (.01 = 3.25)

Test #3

N = 93

Source of variations	Sums of Squares	d.f.	Means Square
Between groups	250.52	5	50.10
Within groups	11,230.95	87	129.09
Total	11,481.47	92	
$F_{5,87} = \frac{129.09}{50.10} = 2.577$			(.05 = 4.42) (.01 = 9.17)

Test #4

N = 97

Source of variation	Sums of Squares	d.f.	Means Square
Between groups	596.92	5	119.38
Within groups	6085.31	91	66.87
Total	6682.23	96	
$F_{5,91} = \frac{119.38}{66.87} = 1.79$			(.05 = 2.30) (.01 = 3.20)

difference between means statistically significant.

To obtain evidence that the several treatments were effective in teaching spelling, the mean gain between the pre-test and post-test for all Ss was computed. Since the test was composed of a representative sample of the spelling list of 164 words, an estimate of the total mean gain in spelling achievement can be obtained by multiplying the mean of the sample (11.23 words) by 3.28. Thus, the estimated mean gain in achievement for the four-week period was 37 words.

An analysis of variance of the gains under each of the six experimental treatments is presented in Table B. Again, the differences among

TABLE B

Analysis of variance of gain in achievement under six experimental conditions.

Gain Pre- and Post-Test

N = 91

Source of variation	Sums of Squares	d.f.	Means Square
Between groups	122.75	5	24.55
Within groups	3779.01	85	44.46
$F_{5,85} = \frac{44.46}{24.55} = 1.811$			(.05 = 4.42) (.01 = 9.17)

means are not statistically significant.

It is apparent that the data presented in this section fail to show a relationship between step-size, as defined, the use of pictorial cues and achievement in spelling.

Error Rate

Much has been written on the importance of a "low" error rate in student responses to programed material. It is argued that to learn efficiently a student must be right most of the time and he must know whether his response is correct or incorrect (e.g., Skinner, 1958). There is some evidence which casts doubt on this position (Goldbeck, 1960; Moore and Smith, 1962 (a); Moore and Smith, 1962 (b));yet, much more research is required on this issue before one can feel certain of the theoretical position to be taken.

The mean error rate on seven units of programed spelling for each of the six experimental groups is presented in Table C.

TABLE C

Mean error rate for each experimental group.

Experimental Treatment	Mean Error Rate in per cent
Small-step, non-pictorial	2.88
Small-step, pictorial	5.47
Medium-step, non-pictorial	5.72
Medium-step, pictcrial	3.12
Large-step, non-pictorial	2.00
Large-step, pictorial	1.60

An examination of Table C indicates that (a) there was some variation in error rate among the six groups, (b) no pattern relating to step-size and pictorial cueing can be found through inspection and (c) the error rates are within generally accepted limits for programed material. No further

analysis of these data seems warranted, for even though the difference between the smallest mean error rate (1.60) and the largest mean error rate (5.72) may be statistically significant, it is of no practical significance. The mean error rates only indicate that the number of correct responses to a given programed form ranged from 94.28 per cent to 98.40 per cent. When put in these terms, a difference of 4 per cent is not of obvious import.

It is of some interest to note that the group (medium step-non-pictorial) which had the highest mean error rate also had the lowest mean gain. The relationship between I.Q. and mean error rate on the seven units of the program also was significant for this group (rho = .82, $p < .01$), although it was non-significant for the other five groups.

For each group, rank order correlations were computed between post-test scores and the mean number of errors committed on the seven units of programed material. For a one-tail test of significance all of the rho's were significant between the 2 per cent and 5 per cent levels of significance.

Since it is possible that the independent variable of step-size was masked by a comparison of error rates on the total word list, a chi-square test of success or failure on each of the fifty words in the post-test as one variable and size-of-step as the other was run. Only one of the fifty chi-squares met a 5 per cent level of significance, again indicating that no relationship between step-size and achievement in spelling could be found.

To determine the relationship between success in spelling a word correctly on the post-test and the number of frames devoted to that word in the program, a comparison was made between the mean number of failures to spell correctly a word presented in 3 frames in the large-

step version of the program and the mean number of failures to spell correctly the same word presented in 5 or 6 frames in the small-step version of the program. The means were 6.68 and 7.40 respectively. Clearly the number of frames devoted to a word in the program seems not to have influenced significantly success on the spelling achievement test. A similar comparison was made for 4 frame versus 7 frame presentation of a word. The means were 11.64 and 11.20 respectively.

Since the mean number of failures on a word seems not to be related to the number of frames devoted to that word, it is possible that the variances differ, i.e., that more variability will occur on the large-step than on the small-step versions of the program. F-ratios were computed and, again, variances did not differ significantly as a function of the number of frames devoted to a word.

Types of Error

For those who are concerned with programing spelling, it may be of some value to consider the types of errors which were made by Ss in responding to the programed material. More specifically, with what type of frame did Ss have the greatest difficulty? An examination of the sample of programed spelling in Appendix A will reveal that frames can be roughly categorized as follows:

1. Definition frame - A frame in which S is required to select the correct word for the definition provided in the frame and to copy the word in the blank provided. (2%)

2. Syllabication frame - A frame in which S is required to divide a word into syllables. (10%)

3. Phonetic frame - A frame in which S is required to indicate the vowel sounds for a word. (3%)

4. Omitted vowel frame - A frame in which S is required to supply one or more missing vowels. (1%)

5. Omitted consonant frame - A frame in which S is required to supply one or more missing consonants. (1%)

6. Vowel-consonant frame - A frame in which S is required to supply two or more missing letters, at least one of which must be a vowel and one a consonant. (1%)

7. New form frame - A frame in which S is required to write a word in a new form, e.g. a plural. (21%)

8. Test frame - A frame in which only the first letter of a word is given and which requires S to complete the spelling of the word with no other cue. (1.5%)

The per cent given for each of these categories represents the ratio of the number of errors committed by Ss who used the small-step version of the program to the number of errors possible for each category. Only the first three types of frames produced enough erroneous responses to warrant discussion. With only one exception, the errors on the definition frame were errors in copying the word correctly rather than failures to select the correct word for the definition as given. In a sense, these may be errors of perception, that is, the child copies a word incorrectly without knowing that he has done so. This probably arises from a well-developed habit of misspelling the words in question.

The large number of errors in syllabication and the errors on the phonetic frames probably are the result of inadequate programing. If S is to learn to divide words into syllables or to identify vowel sounds, more than one frame for each process is necessary.

A comparison of the number of errors made on the small-step program with the number made on the large-step program with the syllabication and phonetic frames factored out[1] indicates that Ss made a much larger

[1]The large-step version of the program contained no syllabication or phonetic frames; hence, by removing these from consideration a more direct comparison of errors on these two versions is possible.

proportion of errors on the large-step than on the small-step program. The 32 Ss who used the large-step program made 162 errors on 16,480 frames (.98 per cent) while the 32 Ss who were given the small-step program made 140 errors on 30,528 frames (.46 per cent).

Intelligence and Achievement in Spelling

Positive correlations between spelling and intelligence have been reported (e.g., see the Encyclopedia of Educational Research, 1960, p. 1348). Porter (1961) presents a detailed analysis of his findings on the relationship between these variables in his study of the effectiveness of programed spelling as a teaching method. Porter reports a significant correlation between spelling gains and intelligence for a "low" I.Q. group and a non-significant correlation for the "high" I.Q. group. The difference between the two groups is attributed to different initial abilities in spelling, resulting in a low ceiling for the "high" I.Q. group. (See, also, Irion and Briggs, 1957).

In the present study, rho's between I.Q. and scores on the post-test in spelling were computed for each of the six experimental groups. All of them were significant beyond the 5 per cent level of confidence. Rho's also were computed between pre-test scores in spelling and I.Q. and all were significant beyond the 5 per cent level of confidence. These data give no support to those who have voiced a fond hope that programed learning will greatly reduce the influence of individual differences in achievement, (e.g., Skinner, 1954).

DISCUSSION

Although few investigators working in the area of automated instruction have stated specifically that achievement on a specific unit of programed instruction is a function of error rate, it has been implied in some instances. In this study, it was hypothesized that

achievement may be independent of error rate; therefore, a careful analysis was made to determine the effects of the independent variables (size-of-step and cueing) on both the criterion measure and error rate. Further analyses were completed in an attempt to determine what relationship, if any, existed between these two variables.

As indicated in Table A, neither size-of-step nor pictorial cues seemed to affect significantly the scores on the criterion measure. This would seem to suggest that the range in size-of-step and cueing from the small-step, pictorially-cued program to the large-step, non-pictorially-cued program, all met the conditions necessary for learning. Further support for this conclusion is provided by examining the mean error rates for the six groups. Although it would seem to be fallacious to conclude that error rate is not affected by size-of-step and/or cueing, (Goldbeck, 1960), an explanation for the small differences observed in this investigation might be that the large-step program was satisfactory for teaching the spelling effectively; therefore, the additional frames were unnecessary, and/or the differences in size-of-step and cueing among the several forms of the programs were not sufficient to produce differences in error rate. Since the greatest error rate for any of the groups was only 5.72 per cent, it would seem that the first explanation is more acceptable.

Although the mean number of errors was not found to be significant for any of the groups, a significant relationship was obtained for all groups when error rate and scores on the post-test were compared. This provides some support for those investigators who have expressed the belief that special criterion measures are unnecessary for assessing a student's achievement after he completed a course which has been programed. This view assumes that the magnitude of the error rate is all that must be considered.

An explanation for the apparent inconsistency in results (i.e., significant correlations between error rate and post-test scores and non-significant differences among groups on weekly test scores and gain scores) is that the linear relationship observed between the error rates and post-test scores may have been a characteristic of the type of material programed. Through inspection it was found that a word misspelled on the first frame was often misspelled on later frames and also on the criterion measure. From this it could be hypothesized that the students may have learned previously to spell these words incorrectly and they persisted in committing the same error in spelling the word when programed. If this hypothesis were true, it would follow that a significant relationship would not exist between the number of frames devoted to the word and the mean number of failures to spell the word correctly on the criterion measure. Since none of the correlations between these two variables were found to be significant, it is believed that some confidence can be placed in this explanation.

As was indicated earlier, a meaningful relationship between error rate and gains on the criterion measure was observed in only one of six groups. This relationship can be considered to be of some importance particularly when a significant relationship between I.Q. and the mean error rate for this group also was obtained. The only meaningful explanation for this finding is that one experimental group differed from the other five groups in some systematic way.[1]

The claim that students of varying levels of ability, who have completed a programed course, will vary little in their acquisition of

---

[1]Although I.Q.'s of the group did not differ significantly after random assignment of the groups, the chance differences among the groups may not have been controlled by the random assignment.

the material was not supported in this study. The fact that all correlations between I.Q.'s and post-test achievement scores for all groups were significant beyond the 5 per cent level would seem to indicate that individual differences in achievement were not greatly affected by the programed material. This is not to say that auto-instructional materials do not increase the overall level of achievement of students, but that sharp individual differences in achievement still exist for those individuals who have learned with programed material.

CONCLUSIONS

1. Size-of-step and pictorial cueing did not affect (a) the achievement on weekly tests in spelling, or, (b) gains between pre- and post-tests of spelling.
2. A significant relationship between error rates and mean scores on the post-test was found.
3. Size-of-step and pictorial cueing did not produce large differences in mean error rates for the six experimental groups.
4. A significant relationship between the ability of the student participating in the program and the mean number of spelling words missed on the post-test was obtained.

Generally, it can be concluded that all six methods used for teaching spelling were equally effective. Since the large-step version of the program was as effective as the small-step version of the program, and the former required less time for completion, it seems reasonable to conclude that programs which contain very small steps are not necessarily desirable. Further, if very small steps and over-cueing are interpreted by S as unnecessary repetition, the additional hazard of a possible loss of interest in the material is an undesirable by-product.

Further study is suggested in at least two areas. First, a

comparison of error rate and criterion measures of the learning gained from the use of auto-instructional materials and second, an investigation of a method of teaching spelling which will provide a means of extinguishing misspellings in addition to teaching new words.

REFERENCES

Amsel, Abram. Error responses and reinforcement schedules in self-instructional devices. In: Lumsdaine, A.A. & Glaser, Robert, (Editors) Teaching Machines and Programmed Learning, Washington, D. C., DAVI, 1960, pp. 540-563.

Carr, W. J. A functional analysis of self-instructional devices. In: Lumsdaine, A.A. & Glaser, Robert (Editors) Teaching Machines and Programmed Learning, Washington, D.C., DAVI, 1960, pp. 540-563.

Goldbeck, R.A. The Effect of Response Mode and Learning Material Difficulty on Automated Instruction, American Institute for Research, Technical Report No. 1, 1960.

Holland, J. G. "Teaching machines: An application of principles from the laboratory". Princeton: Proceedings of the Educational Testing Service Conference, Educational Testing Service, 1960.

Irion, A. L. and Briggs, L. J. Learning Task and Mode of Operation Variables in Use of the Subject Matter Trainer. Lowry Air Force Base, Colo.: Air Force Personnel and Training Research Center, October, 1957. Technical Report AFPTRC-TR-57-8.

Lumsdaine, A.A. Some issues concerning devices and programs for automated learning. In: Lumsdaine, A.A. & Glaser, Robert (Editors) Teaching Machines and Programmed Learning, Washington, D. C., DAVI, 1960, 517-539.

Moore, J. W. and Smith, Wendell. A comparison of various types of immediate reinforcement as they affect achievement in a verbal task. In: Smith, Wendell & Moore, J.W. (Editors) Programmed Learning, Princeton: Van Nostrand, 1962.

Moore, J. W. and Smith, Wendell. Knowledge of results in self-teaching spelling. In: Smith, Wendell & Moore, J.W. (Editors) Programed Learning, Princeton: Van Nostrand, 1962.

Porter, Douglas. An Application of Reinforcement Principles to Classroom Teaching: The teaching of phonemically and orthographically analyzed spelling materials by an automatic teaching device. Cambridge: Harvard University, Laboratory for Research in Instruction, 1961, 117 pp.

Skinner, B. F. The science of learning and the art of teaching. Harvard Educational Review, 1954, 24, 86-97.

Skinner, B. F. Teaching machines. Science, 1958, 128, 969-977.

APPENDIX A

BIOGRAPHICAL CONTEXT

LEONARDO DA VINCI (I)[1]

Leonardo da Vinci was one of the geniuses of early seventeenth century Italy. He was hired by different princes as an artist, architect, civil and military engineer and designer.

As an artist, he was both sculptor and painter. Today his works can be seen in Italian cathedrals and as exhibits in museums all over the world. Many famous art collections include some of his work. Even medicine owes him a debt because of his excellent drawings of the human body, which medical students are still using.

As an architect and designer, he directed the construction of roads and public buildings all over Italy. His most ambitious project was to divert the course of the Arno River, so that it would be navigable for river boats. Sadly, he did not succeed.

LEONARDO DA VINCI (II)[1]

Leonardo da Vinci was also famous as a military engineer, that is, he constructed weapons and fortifications. He was never satisfied with the weapons of his day, but was always planning for the future. He left plans and models of a machine gun, a tank, a helicopter, several types of airplane and a parachute.

You can easily imagine just how frightened the enemy soldiers of that time would have been in a battle against such secret weapons. But da Vinci was never able to build any of them. People did not believe that such things were possible. Even if he had been able to explain and describe them, he could not have gotten the materials to build them. Most of his plans in this field were forgotten for hundreds of years.

---

1. The words to be learned are underlined

SAMPLE SET OF FRAMES

1. Which word means "making a plan or thinking about something in the future"? Copy the word.

   forgotten weapons helicopter planning

   _____

2. Divide the word planning into syllables (2). Put a dash between each syllable.

   _____

3. To make another form of the word plan, double the n (nn) and add your new ending (ing). Write a form of the word plan.
   The girls were _____ a party for Saturday.

   _____

4. In the word planning both the vowels have the short sounds (ă,ĭ). Write the word and mark the vowels to show this.

   _____

5. Write the missing letters. They are the same. If we are pla _ _ ing for the future, we are not looking at the past.

   pla _ _ ing

   _____

6. She was pl _ nn _ ng a party for his birthday.

   pl _ nn _ ng

   _____

7. Careful p _ _ _ _ ing is often time well spent.

   p _ _ _ _ ing

   _____

8. Careful p_____ many times helps you avoid mistakes.

   p_____

   _____

Title of Unit	Number of words Programed	Number of Frames in the Unit		
		Large-Step	Medium-Step	Small-Step
Booker T. Washington and George Washington Carver	21	76	105	141
Benedict Arnold (I)	21	76	110	142
Benedict Arnold (II)	21	81	114	151
Phileas Fogg	22	75	109	141
Paul Revere	19	57	76	101
Johnny Tremain	18	67	92	124
Leonardo da Vinci (I)	21	81	114	154
Leonardo da Vinci (II)	21	83	118	154
Total	164	596	838	1108
Total, less Leonardo da Vinci (I)	143	515	724	954